Wastewater Management: New Technologies for Treatment

➤➤ *By Suketu Shah*

The traditional methods of wastewater treatment becomes increasingly challenged with the identifcation of more and more contaminants, rapid population growth, increasing industrial activities, and ever shrinking fresh water sources. Conventional process has been proven in removing many chemical and microbial contaminants from wastewater. However, the effectiveness of these processes has become limited over the last two decades because of new challenges; increased knowledge about the consequences from water pollution and public demand for better quality water have enforced the implementation of much stricter regulations by expanding the scope of regulated contaminants and lowering the maximum contaminant levels set for wastewater discharge. Among them, the most signifcant are to remove nutrients (nitrogen and phosphorus) and synthetic organic compounds (SOCs) because of their signifcant impacts on public health and the environment.

> Aging Infrastructure, Conventional Technologies and Microbial or Chemical Contamination are major threats to Public Health.

The second factor is the shrinking water resources and rapid population and industrial growth. The reuse of municipal and industrial wastewaters and the recovery of potential pollutants used in industrial processes become more critical. This is especially true in dry areas where the drinking water is transported at great expense.

The reclamation has become more important with the growing concern over the contamination of water resources due to toxic compounds released by the industries. Advanced treatment technologies are required to remove various potentially harmful compounds that could not be effectively removed by conventional treatment processes.

The third challenge is advancement in the manufacturing industry and the growing market of advance treatment processes that resulted in substantial improvements of these processes at the industrial level.

To address these new challenges, a variety of new wastewater treatment technologies such as membrane filtration systems, automatic variable filtration (AVF), advanced oxidation processes (AOP), UV irradiation has been proposed, tested and applied to meet both current and anticipated treatment requirements. These new treatment technologies have been proven to successfully remove a wide range of challenging contaminants from wastewater.

WATER STRESS

The global dynamics are changing rapidly, faster growth in world population together with rising standard of living and increasing consumption pattern including water has resulted in resource crunch. The demand for water is increasing that exceeds the current resources available on the earth surface. It is estimated that by the year 2050, the world population will become 9 billion from the current population of 7 billion, with the standards of living continue to rise, the amount of water required then will be about three times of the present availability. At present, there are almost a billion people who do not have access to safe drinking water and more than 80% of the used water is not treated before disposing it off to water bodies. As the emerging scenario call for immediate and essential actions, we need to recycle and reuse all types of resources including water. Water stress further aggravates when the abstraction and use of water is much higher than being returned and that too with harmful pollutants in it. The global climatic changes will further reduce our water resources. Clearly, we need more efficient treatment technologies and water management to meet the global needs.

WASTEWATER AS RESOURCE

Innovations in the area of wastewater treatment focus on the principle that wastewater can be a resource. The innovations in this field often use new technologies and ideas; their underlying philosophy revolves around the simple wisdom, reuse of wastewater results in less extraction of water and thus saving the fast depleting natural resource from extinction. It's a good proposition to address the ever increasing water demands and exploring new ideas for wastewater treatment.

The reuse and resource recovery from wastewater will depend on a number of factors including operating costs, potential revenues, the value of the resources and public acceptance for wastewater resources and the engineering needed to create them. The bulk of the domestic and commercial water supply is of non-potable water, which can be supplied from recycled water and stored rainwater thus leaving the fresh water sources for drinking purposes. The challenge is to develop and implement new ideas for wastewater treatment and resource management with supporting technologies, only then we will have sustainable systems for the future.

NEW TECHNOLOGIES FOR WASTEWATER TREATMENT

Wastewater treatment involves reduction in pollutants in process from wastewater and proper operation and maintenance of the plant to obtain the desired performance. Wastewater treatment technologies are crucial for urban water systems. Some of the new technologies being used and introduced for wastewater treatment globally to reclaim the resources:

MEMBRANE FILTRATION

Membrane filtration is essential to the development of advanced water reclamation systems and the development of new and improved systems is expected to continue. Micro and ultra-filtration membranes provide excellent pre-treatment to remove a wide range of dissolved contaminants. Membrane bioreactor filtration technology is being extensively used for advanced treatment to produce water for reuse by the industries. With MBRs,

complete biological treatment and the retention of pathogens including viruses has become possible; treatment with membrane bioreactor produces a highly clarified effluent that can be more easily disinfected. Thus treatment with MBR followed by RO and UV treatment is ideal for producing non-potable water.

NANOTECHNOLOGY

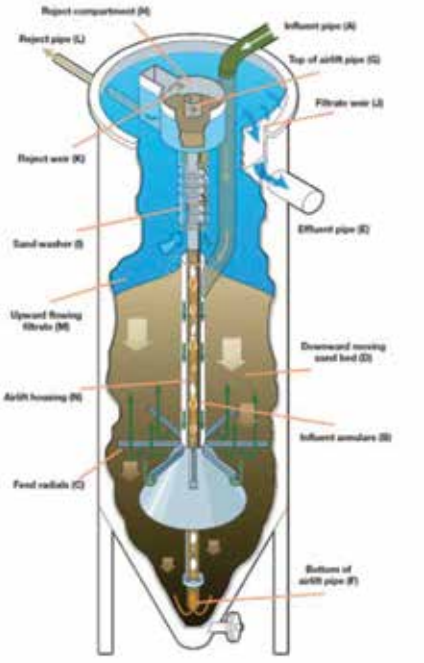
The emergence of nanotechnology and the incorporation of living microorganisms in bio-microelectronic devices has revolutionized the treatment process. The best part of nanotechnology is that it can easily merge with other technologies and modify, endorse and clarify any existing concept. It offers innovative approach to develop and exploit these processes in completely new ways. Nanotechnology concepts are being investigated for higher performing membranes with fewer fouling characteristics and improved hydraulic conductivity. A number of new researches are being conducted for producing fabrication of membranes from nano materials for decomposition of toxic compounds during the treatment. It will also provide effective segregation of metals, bimetallic nano particles, mixed oxides, zeolites and carbon compounds etc from the wastewater resources. With improved membranes and configurations, more efficient pumping and energy-recovery systems will be possible.

AUTOMATIC VARIABLE FILTRATION (AVF) TECHNOLOGY

Automated Variable Filtration (AVF) technology is a state of the art technology used for wastewater treatment in which upward flow of influent is cleaned by downward flow of filter media. During the treatment process itself, the filter media is cleaned by the filtered influent thus there is no requirement for any additional filter media cleaning or fresh water. The AVF process comprises two sets of media filters that can be operated in series or in parallel. The two stage series configuration is used to produce very high quality filtrate. This mode is ideal for refining secondary wastewater for reuse. The AVF process is equipped with actuated valves, sensors and programmable logic controllers to automatically switch from serial mode to parallel mode during wet weather conditions or other preset operating conditions.

The key benefits of the system are:

- Higher solids capacity
- Continuously cleaned media beds
- Elimination of ancillary equipment
- Even flow distribution
- Cost effective to install and low operating and maintenance costs
- Average reject of 5-15%
- Extremely low power consumption
- Ease of Operation & Maintenance



MICROBIAL FUEL CELLS

Microbial fuel cells is a breakthrough technology where electrical energy could be extracted directly from organic matter present in the waste stream by using electron transfer to capture the energy produced by microorganisms. Microorganisms

are grown as a biofilm on an electrode; the electron donor is separated from the electron acceptor by a proton exchange membrane, which establishes an electrical current. This technology is still in its development stage and significant advances in process efficiency and economics will be necessary before it could be used widely to produce electrical energy directly from organic matter present in the wastewater.

NEW URBAN SANITATION TECHNOLOGY

The New Urban Sanitation Technology aims at wastewater treatment with reuse of energy and minerals with a combination of Electro flocculation (Elflox) and Anaerobic Digestion technologies.

Elflox treatment is based on separation of the organic pollution from community wastewater with Electrocoagulation (ECF reactor). Organic sludge of the ECF reactor is sedimented in a circular sedimentation vessel, Sludge (organic compound) which then fed to anaerobic reactor gets converted Biogas which can be converted in to Energy for captive utilization.

Anaerobic fermentation technology, generates optimum Biogas due to two separate processes of Hydrolysis- the long-chain carbon compounds is broken down into smaller compounds such as fatty acids; and Methanogenesis the fatty acids gets converted into biogas.

NATURAL TREATMENT SYSTEMS

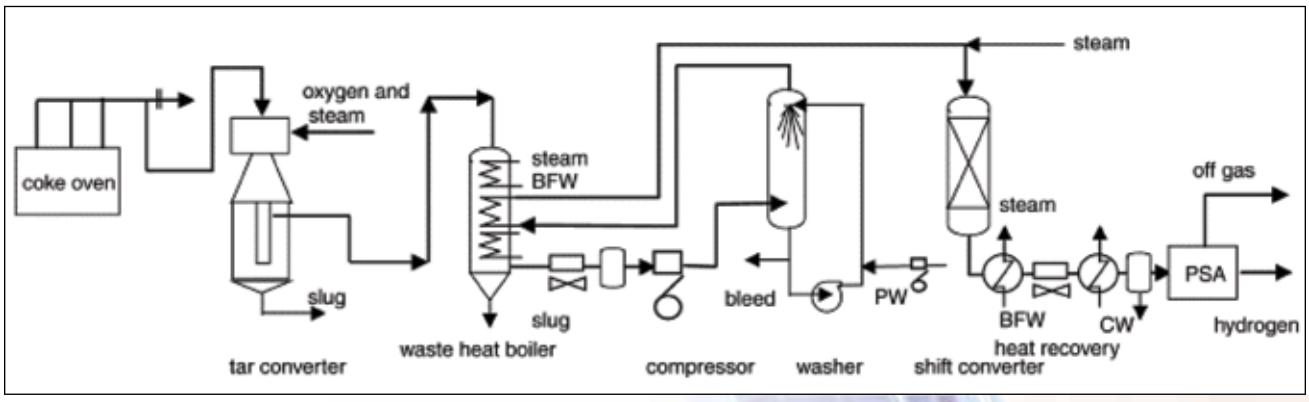
The natural treatment systems (NTSs) is also improving with the emergence of new methods and technologies and a variety of physical, chemical and biological processes work simultaneously to remove a range of contaminants comprehensively. Natural treatment systems are increasingly being used to capture, retain and treat storm water, thereby converting this sheer wastage into a valuable source of water. These natural systems have the advantage of being able to remove a wide variety of contaminants including nutrients, pathogens and micro-constituents including endocrine disrupting chemicals. This treatment process is very effective for water reclamation.

The steel producing plants in India are using this treatment process to recover ammonia from cokeoven liquid. Water pollution problems would be worse if ammonia is not recovered, the most polluting among all the wastes from production units. In the CO effluent, most of the pollutants are in the dissolved state. Other pollutants are subjected to biological treatment along with residues of phenol and ammonia. The two most common processes used for the treatment of cokeoven effluents are trickling filter and activated sludge process.

URINE SEPARATING PROCESS

Urine is part of domestic wastewater which contains up to 90% of the

Cokeoven (CO) Byproduct Wastewater Treatment



nitrogen and 50% of the phosphorus. The development of urine separating toilets and technologies for treating it to produce fertilizer products is a key to managing nutrients with minimal requirements for outside resources, such as additional energy. Producing the same amount of petroleum-based, nitrogen-rich fertilizer takes an enormous amount of energy and non-renewable resources.

Urine-separating toilets have already been developed and advanced research is going on to refine it further and use them for wastewater management and creating resources.

WAY FORWARD

These new treatment processes with resource recovery along with the integration of urban water and waste management systems will improve the sustainability of our water resources. New wastewater treatment technologies can significantly reduce water abstraction from our already resource constrained world. Reclaim water must be managed properly to maintain the integrity of the overall treatment system. The energy consumption in treatment plants also requires active management to make the entire process efficient and effective. Technologies to meet these challenges already exist and work is going on to refine and integrate them into higher performing more sustainable systems. The challenge is to choose the most appropriate one from the available options and developing institutional arrangements for implementing them in the most effective ways.

ABOUT AUTHOR

Suketu Shah, the co-founder and Managing Director of Oxive Environmental Management Pvt. Ltd., has been in the field of Environmental Engineering & Consultancy for over 20 years. He has been actively involved in completion of over 200 environmental projects.

Mr. Shah has subject expertise in the field of Environmental Engineering which involves Recycle and Reuse of Waste and Energy Generation both in the solid and liquid waste management sectors. He is a Certified Environmental Management Systems (EMS) Auditor.

Mr. Suketu Shah has been the recipient of the "VIJAYRATNA AWARD" for enriching human life and outstanding attainments from International Friendship Society of India. He has earned his degree in Environmental Engineering from University of Bombay.